Subtypes and Supertypes

Object-Oriented Analysis and Design

CSCI 6448 - Fall 1998

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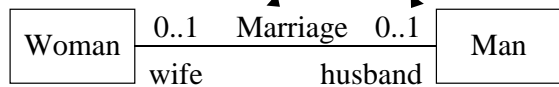# Goals of this Lecture

- Examine the concepts of
  - Classification (Review)
  - Generalization
    - Inheritance
  - Aggregation
    - Types of Aggregation

But first…

The role name specifies the part the associated class plays in the association

Relationship Name

Cardinality

| Woman | 0..1 | Marriage | 0..1 | Man |

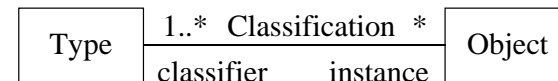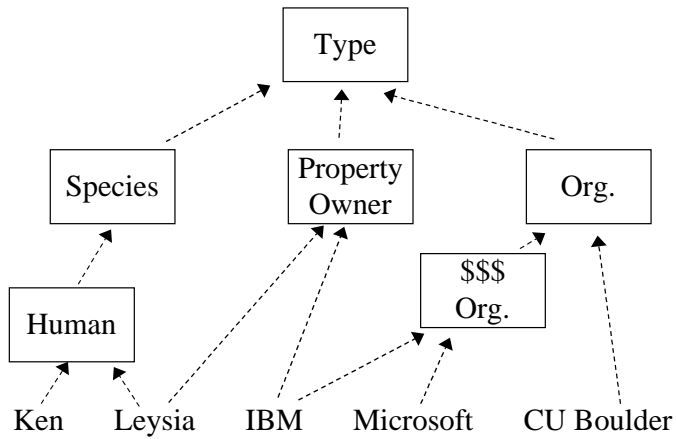wife   husband

Role

Mapping Name (from the perspective of the Woman)

Classification

- Definition
  - Classification is the act or result of applying a concept (i.e. type) to an object.

| Type | 1..* | Classification | * | Object |

classifier   instance

Classification Hierarchies

```
              ┌──────┐
              │ Type │
              └──────┘
           ↗     ↑     ↖
  ┌─────────┐ ┌──────────┐ ┌──────┐
  │ Species │ │ Property │ │ Org. │
  └─────────┘ │  Owner   │ └──────┘
              └──────────┘
      ↑         ↑    ↑    ┌──────┐    ↑
  ┌───────┐    │    │    │ $$$  │    │
  │ Human │    │    │    │ Org. │    │
  └───────┘    │    │    └──────┘    │
   ↑    ↑      │    │      ↑         │
  Ken  Leysia  IBM  Microsoft  CU Boulder
```

Classification vs. Generalization

- Classification simply applies types to objects
    - It does not specify that one type is a subtype of another
- For example, in the previous diagram
    - Ken is an instance of the type Human
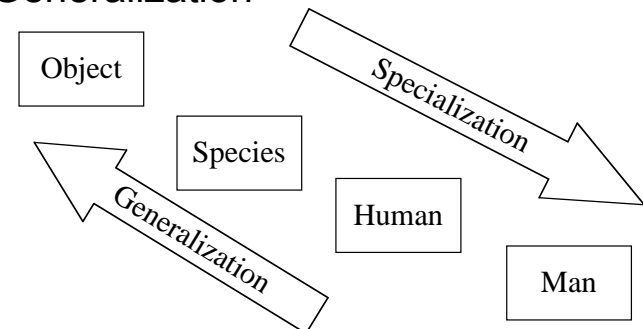   - No relationship between Ken and Species has been specified

Generalization

- Definition
    - Generalization is the act or result of distinguishing a concept that completely includes or encompasses another.
- Thus
    - It allows us to specify that all instances of a specific type are also instances of a more general type

Specialization

- Specialization is the opposite of Generalization
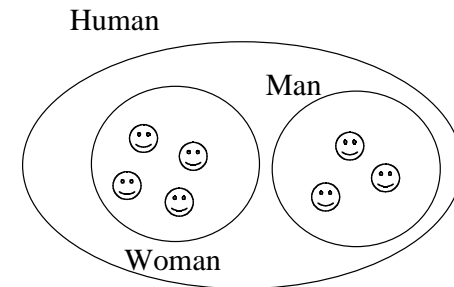
Subtypes and Supertypes

- Subtypes are created by specialization
- Supertypes are created by generalization
- Two sides of the same coin
- Thus
  - Man is a subtype of Human
  - Species is the supertype of Human

Relationship to Sets
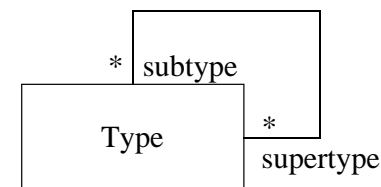
Relationship to intension and extension

- Subtype
  - definition is more specialized than another
  - Set members are all included in a more encompassing set
- Supertype
  - Definition is more general than another
  - Set includes all the members of one or more sets

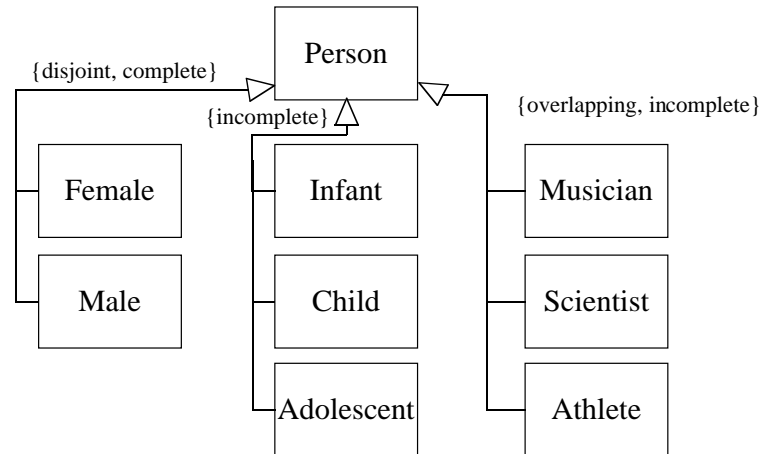## The Subtype-Supertype Association

Type Partitions

- **Definition**
  - A type partition is a division of a type into disjoint subtypes
  - Each partition can contain non-overlapping subtypes that capture a particular classification of the supertype
- **Example**
  - Person -> Gender, Age, Profession, etc.

Example

{disjoint, complete}   Person   {overlapping, incomplete}

{incomplete}

Female

Male

Infant

Child

Adolescent

Musician

Scientist

Athlete

Definitions

- **Complete partition**
  - Partition with all of its subtypes specified
- **Incomplete partition**
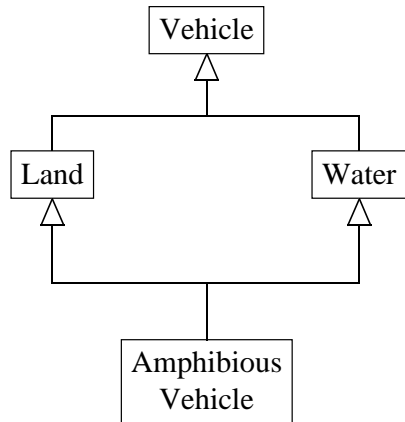 - Partition with only a partial list of subtypes
  - In elaboration, you may start out with an incomplete partition and evolve towards a complete one

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Multiple Supertypes

- A type can have multiple supertypes
  - Such types possess all of the attributes and behavior of each of their parents

Multiple Supertypes Example
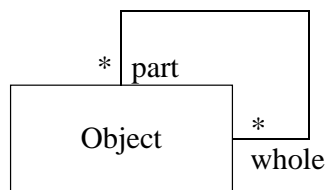

Vehicle
Land   Water
Amphibious Vehicle

Inheritance

- Inheritance is an implementation of subtyping
  - It is a programming language mechanism that enables code reuse between a class and its subclasses (subtypes)
  - Multiple Supertypes is provided by some languages as multiple inheritance
  - Other languages provide it via interfaces

Aggregation

- Aggregation is the act or result of forming an object whole using other objects as its parts

* part
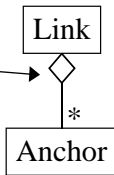Object   * whole

Aggregation vs. Composition

- Aggregation is a part-of relationship
  - A wheel is part of a car
- Composition is a stronger version of this relationship
  - The part may belong to only one entity and it lives and dies with the entity
  - That is, if you delete the whole, you delete its parts as well

Chimera Example

- A Chimera link could be thought of as an aggregation not a composition
- When you delete a link, its anchors can still exist after its gone
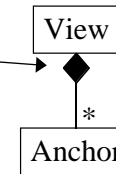
An aggregation has a clear diamond →

Link
◇
*
Anchor

Its not really a true aggregation however since multiple links can share the same anchor

Composition Example

A composition has a black diamond →

View
◆
*
Anchor

If a Chimera view is deleted, then all of its anchors are deleted as well

Aggregation Properties

- Configuration
  - The parts bear a functional or structural relationship to each other or to the whole
- Homeomerous
  - The parts are the same type as the whole
- Immutability
  - The parts cannot be separated from the whole

Six different types of aggregation

- Component-Integral Object
  - Scenes are parts of films
- Material-Object
  - A cappuccino is partly milk
- Portion-Object
  - A meter is part of a kilometer

Aggregation Types, continued

- Place-Area
  - Boulder is part of Colorado
- Member-Bunch
  - A tree is part of a forest
- Member-Partnership
  - Grady Booch is part of the three amigos